Ozone Study
Background and Goals

- Determine the impact of oil and gas development on regional ozone
- Investigate regional patterns and causes of high ozone concentrations
- Develop a more accurate conceptual model of regional ozone in Utah and surrounding States

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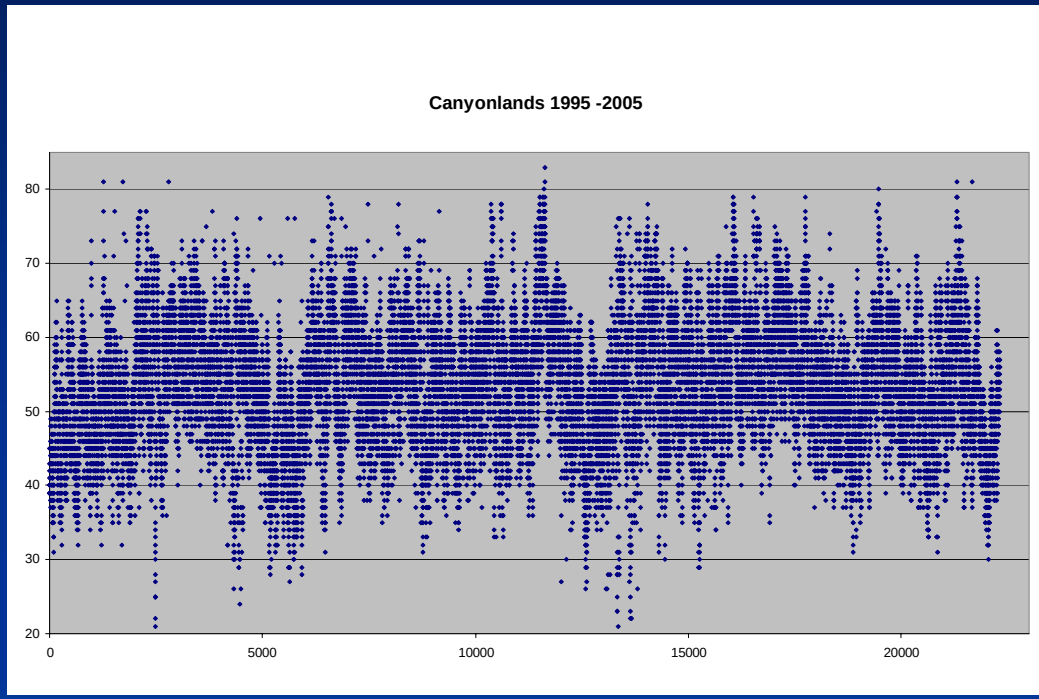
Ozone Study

Ozone Data Selection

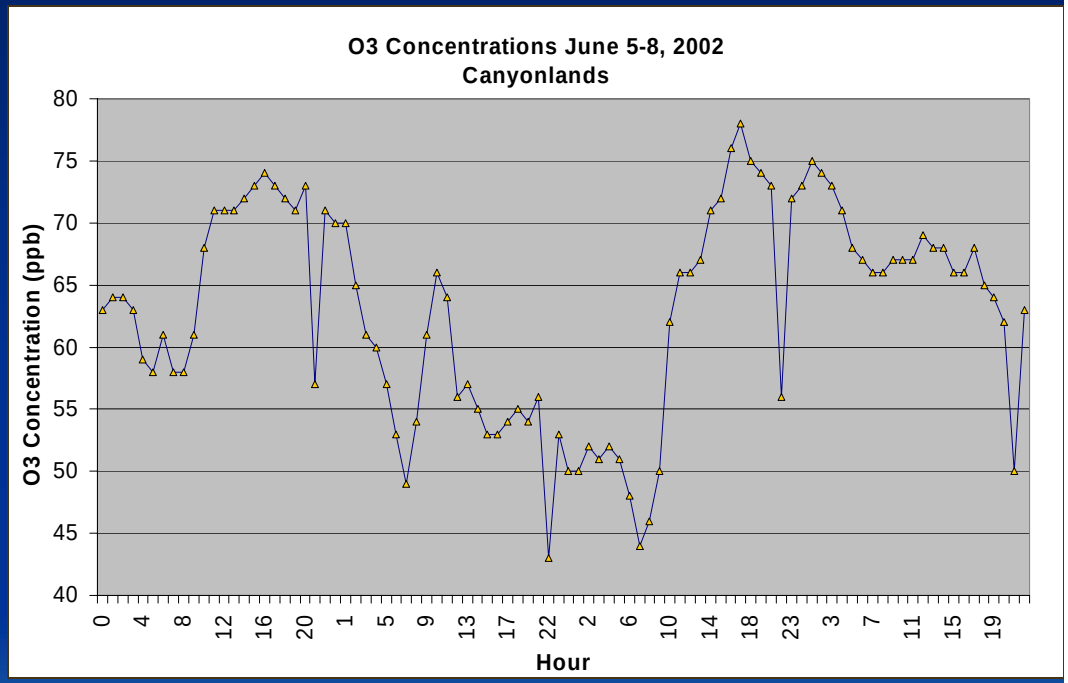
- Data was sought from sites with proximity to oil and gas development
- A lengthy data record was desired
- Data was sought from a site without variation in its location over the sampling period
- Canyonland's ozone monitor provided desired data criterion with a 10 year data record



Ozone Study

Episodic Analysis Development

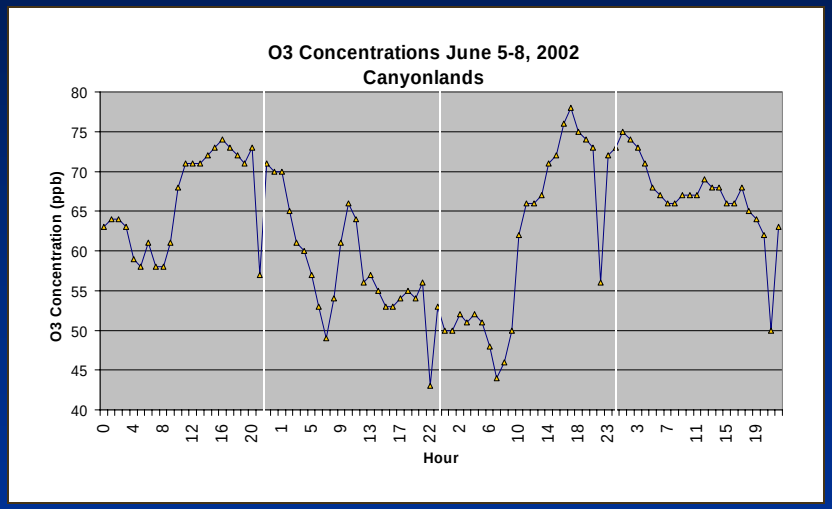
- Due to the limitations of a long term analysis episodic analyses were performed
- Analyzing individual event periods allowed our conceptual model of regional ozone production and transport to be tested and refined
- Once the decision was made to use an episodic analysis two test cases were selected

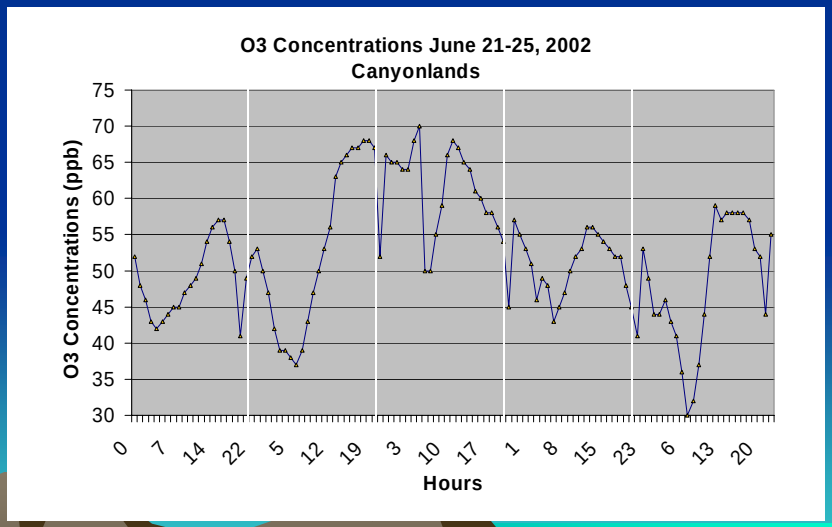


Ozone Study

Event Selection

- Two event periods were selected to test methodology (June 5-8, 2002 and June 21-25, 2002)
- Both events occurred in June and were associated with interesting changes in inter or intra-day ozone levels
- The events selected were chosen because of their unique ozone fluctuations



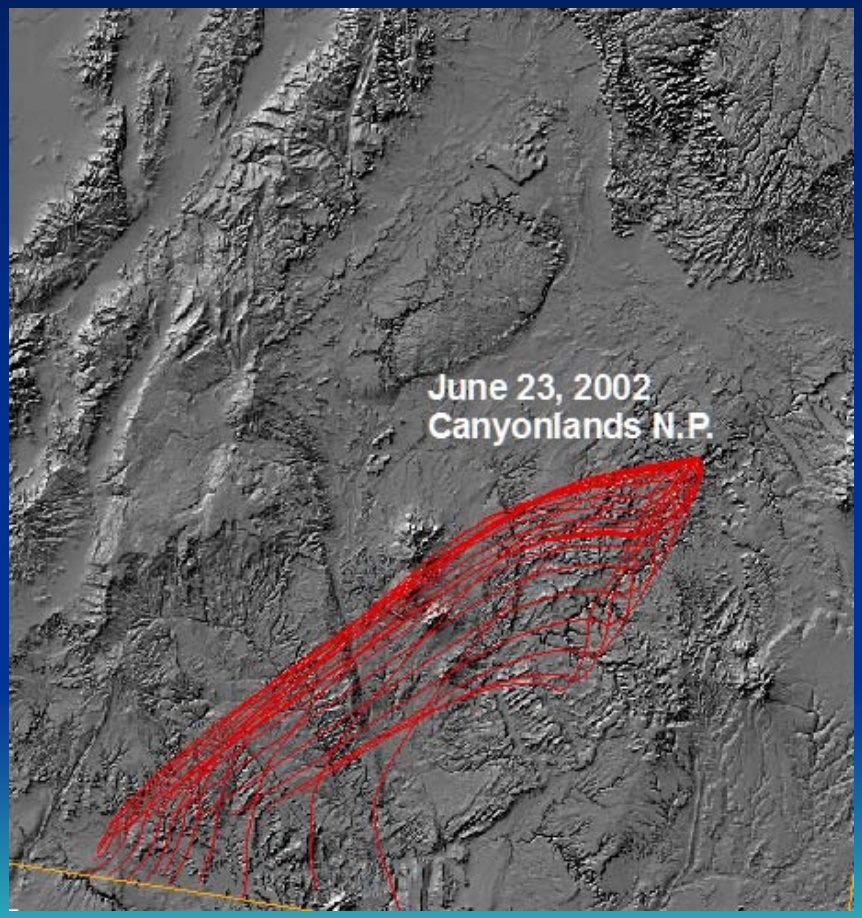


Ozone Study
Mitigating Natural Impacts (Fires)

- Fire can significantly influence regional ozone levels without providing information as to anthropogenic influences on ozone
- Events selected were chosen to avoid large wild-fire events in the intermountain region
- Fires were tracked during episode time periods to determine if regional fires could influence ozone levels at Canyonlands
- Early season event periods were preferred because of the reduced chance of large fire event influence

Ozone Study
Utilizing HYSPLIT Back Trajectories

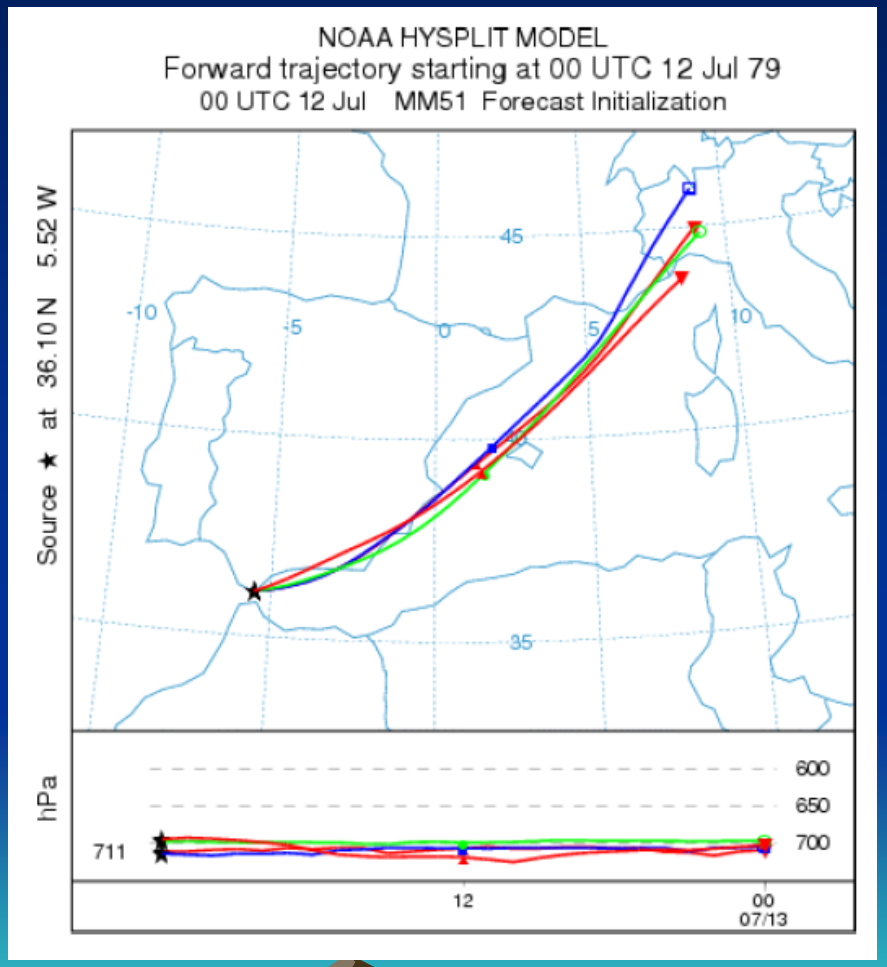
- In order to determine areas of influence for ozone transport HYSPLIT was utilized
- Back trajectories were performed for each hour of the events running backwards 24-hours
- The trajectories are representative of air that ended at the Canyonland's ozone monitor at ground level
- On a whole, the trajectories gave an indication of source region for regional ozone transport



Ozone Study

Trajectory Assumptions

- Course meteorological data resolution
- Numerical approximation in the model produces error
- Particles travel only a single path without chemical interactions, deposition, or dispersion
- Parcel trajectories near the earth's surface can vary from actual flows due to thermal effects and complex terrain

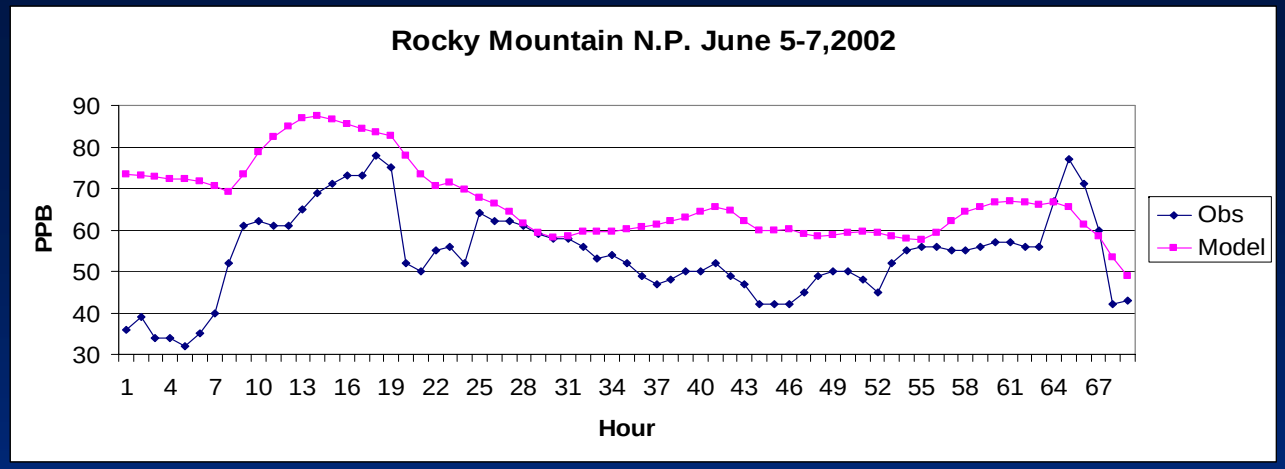


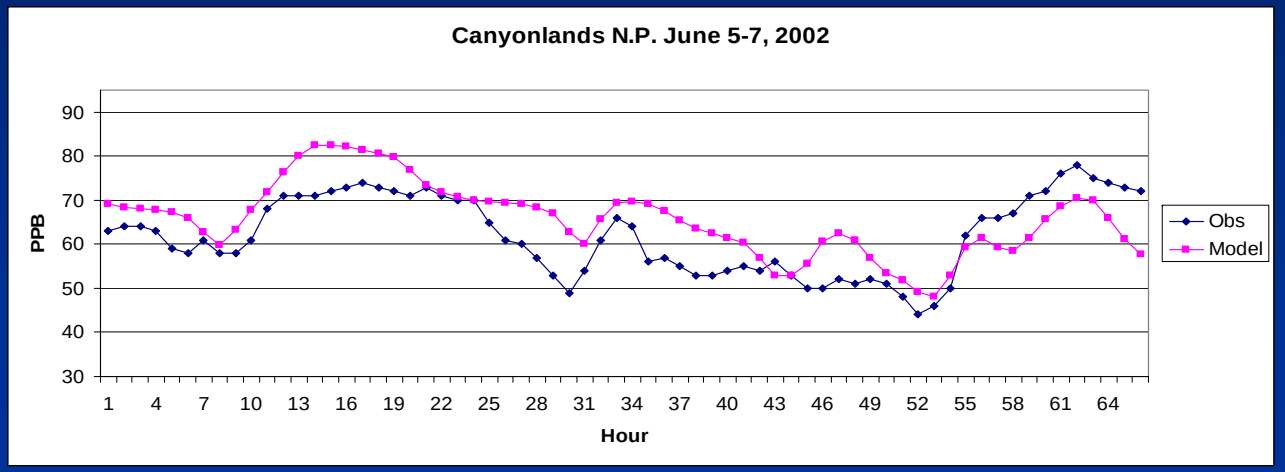
Mean Normalized Bias (MNB): A value of zero would indicate that the model over predictions and model under predictions exactly cancel each other out.

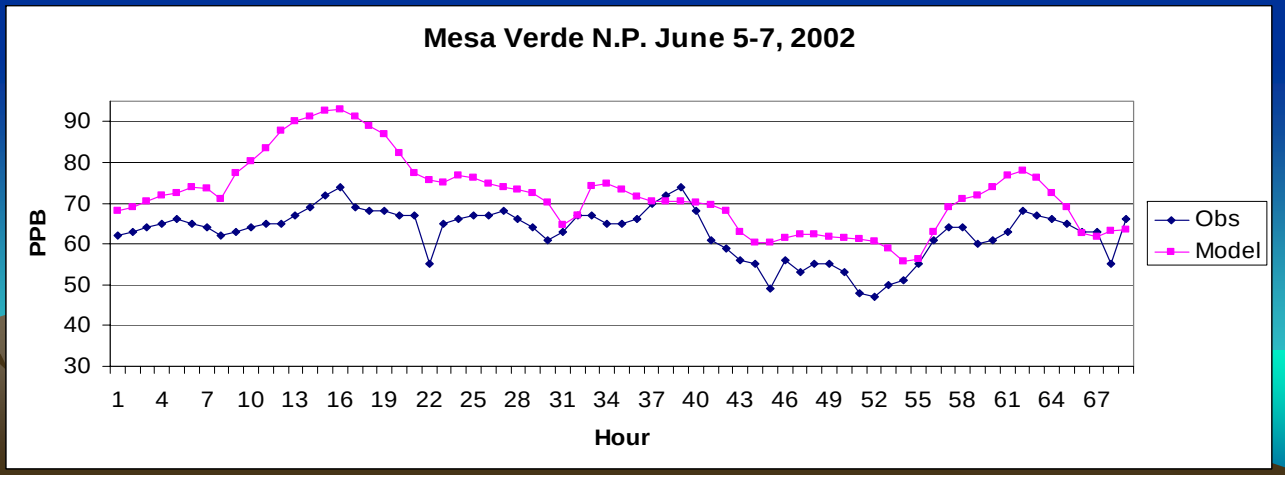
Mean Normalized Gross Error (MNGE): A value of zero would indicate that the model exactly matches the observed values at all points in space/time.

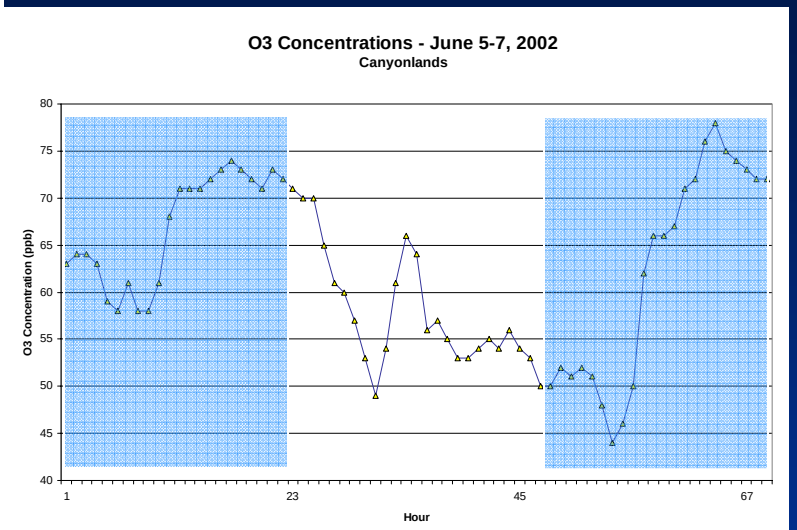
Previous guidance in the modeling community set a goal of: MNB <= 15% and MNGE of <= 25%. This was based on the experience of actual model performance over the years.

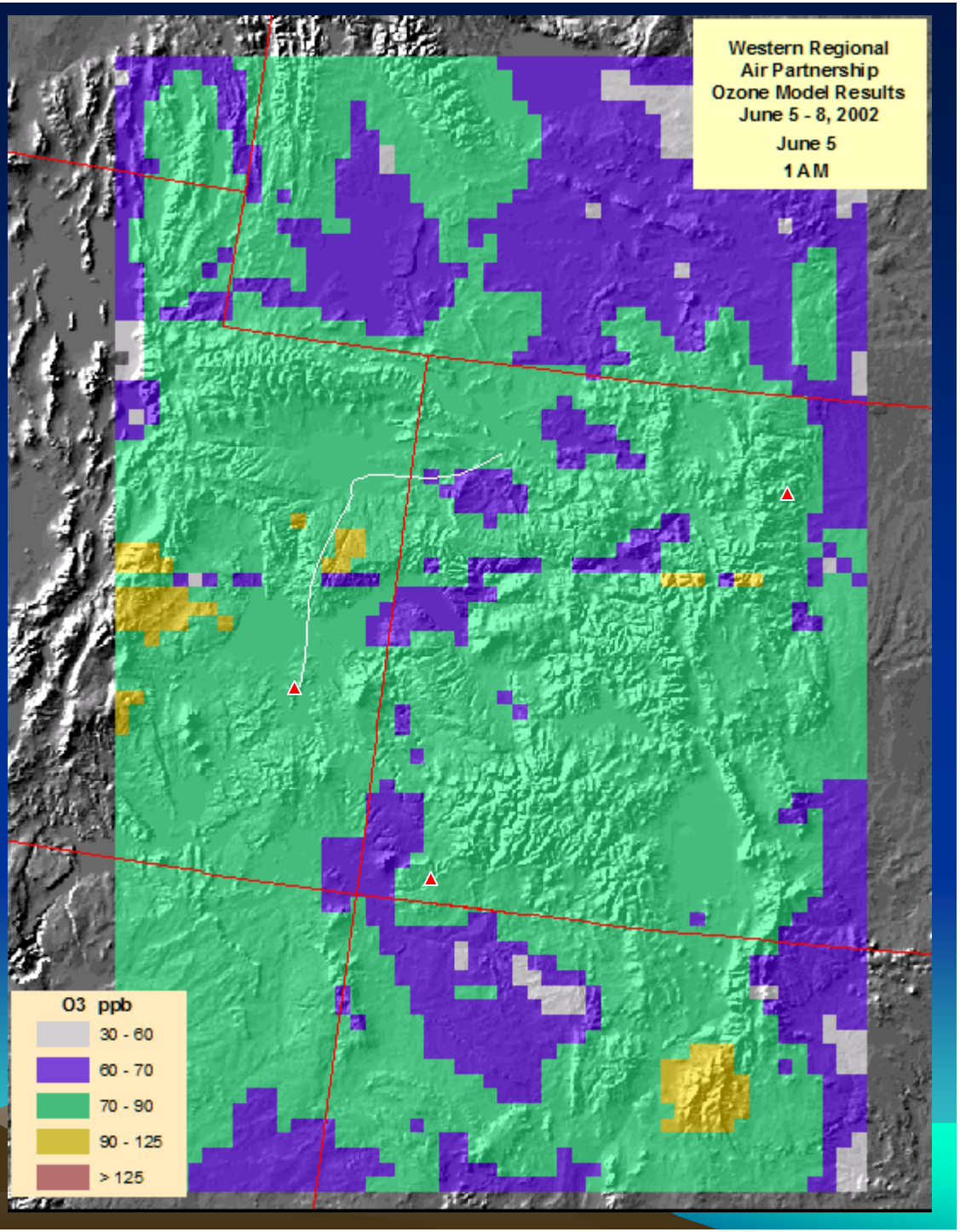
Goal	<= 15%	<= 25%
Monitor	MNB	MNGE
Rocky Mountain N.P.	4%	16%
Mesa Verde	3%	14%
Centennial, WY	-4%	10%
Pinedale	-2%	13%
Gothic, CO	7%	17%
Canyonlands	-3%	12%


Rocky Mountain N.P. June 5-7,2002
PPB
90
80
70
60
50
40
30
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67
Hour
Obs
Model


Canyonlands N.P. June 5-7, 2002
PPB
90
80
70
60
50
40
30
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64
Hour
Obs
Model


Mesa Verde N.P. June 5-7, 2002
PPB
90
80
70
60
50
40
30
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67
Hour
Obs
Model


O3 Concentrations - June 5-7, 2002
Canyonlands
O3 Concentration (ppb)
80
75
70
65
60
55
50
45
40
1
23
45
67
Hour


Western Regional
Air Partnership
Ozone Model Results
June 5 - 8, 2002
June 5
1 AM
O3 ppb
30 - 60
60 - 70
70 - 90
90 - 125
> 125

Ozone Study

Continued Study – CART Development

- The next possible step is to help re-define the conceptual model using statistical methods
- A Classification and Regression Tree (CART) Analysis would allow multiple variables to be assessed as to their usefulness in analyzing the root causes of high O3 concentrations in the Canyonlands area or other regional locations
- Such an analysis would allow clarification as to which regional variables covariate with high O3 concentrations